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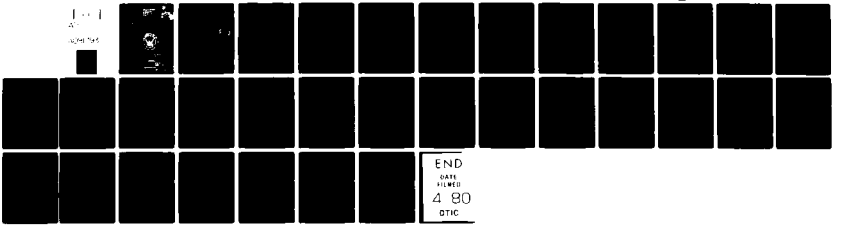

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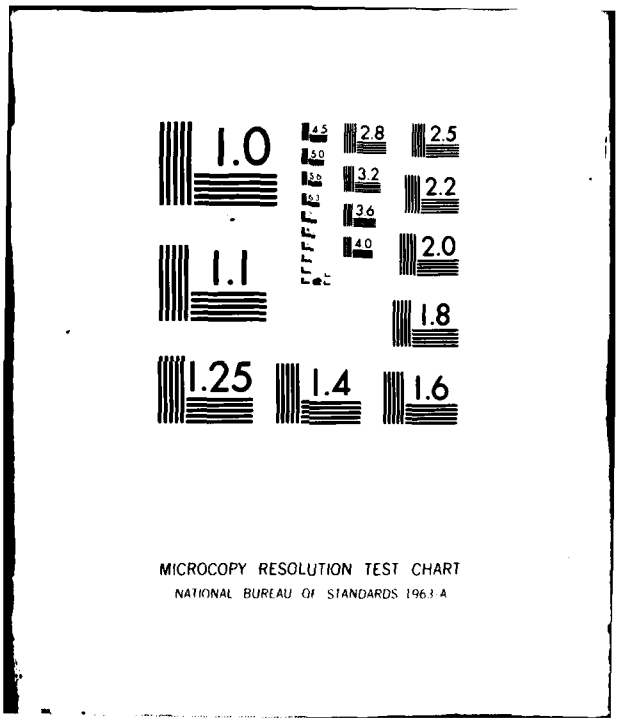
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MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS 1963-A

NUMERICAL PREDICTION OF CURRENTS AND SEA LEVEL IN THE GULF OF SIAM

MARCH 1969

FLEET NUMERICAL WEATHER CENTRAL

MONTEREY, CALIFORNIA

CONTENTS

FOREWORD

This publication is intended for operational use and contains the current predictions for the Gulf of Siam.

The currents were computed with a slightly modified numerical-hydrodynamical method ~~of Professor W. Hansen.~~ The reprogramming WAS DONE ~~for~~ ON the Fleet Numerical Weather Central CDC 6500 computer ~~was done by Dr. Taivo Laevastu in cooperation with Mr. Paul Stevens~~. The properties and limitations of the presented charts are briefly described in this paper. The materials in this paper complement the conventional tide predictions prepared earlier by this command for the Gulf of Siam.

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PAUL M. WOLFF
Captain, U. S. Navy
Commanding Officer

1. NUMERICAL PREDICTION OF THE CURRENTS AND TIDES IN THE GULF OF SIAM

The numerical prediction of tides and tidal currents in the Gulf of Siam has been made with a slightly modified numerical-hydrodynamical (NH) model of Professor W. Hansen.

The basic formulas are:

$$\frac{\partial u}{\partial t} - fv - \nu\Delta u + \frac{r}{H} u\sqrt{u^2 + v^2} + g\frac{\partial \zeta}{\partial x} = X + \frac{\tau(x)}{H}$$

$$\frac{\partial v}{\partial t} + fu - \nu\Delta v - \frac{r}{H} v\sqrt{u^2 + v^2} + g\frac{\partial \zeta}{\partial y} = Y \quad \frac{\tau(y)}{H}$$

$$\frac{\partial \zeta}{\partial t} + \frac{\partial}{\partial x}(Hu) + \frac{\partial}{\partial y}(Hv) = 0$$

x, y	space coordinates
t	time
u, v	components of mean velocity
H	total depth
ζ	surface elevation
X, Y	components of external forces
$\tau(x), \tau(y)$	components of wind stress ($\lambda = 3.5 \times 10^{-6}$)
g	acceleration of gravity
f	Coriolis parameter
r	friction coefficient (3×10^{-3})
ν	coefficient of horizontal eddy viscosity
Δ	Laplace operator

The water level at the southern boundary is described with four harmonic constants of the conventional tide prediction method. In addition to the astronomical tides, a wind induced current and accompanied water level change has been superimposed, using an average climatological wind direction and velocity for late winter and summer.

The NH method has proven to yield results which verify well with actual measurements. However, the following limitations in the presented data must be considered:

1. The presented data refers to the "average" tides, approximately, mean water elevation between the neap and spring tides.

2. The current speed and direction near the coasts and in the vicinity of islands is considerably influenced by the local bathymetry. The coarseness of the computational grid does not allow the presentation of all these details.

3. The sea level refers to a mean level and the tidal heights have both positive and negative signs in respect to this level.

A selected number of tidal currents and tidal height charts are presented to cover one complete tidal cycle. Their relation to the tidal cycle at Ha Tien, used as a reference station, is depicted on Figure 1. Additionally, tidal currents and heights at ten selected locations are given on the location chart, Figure 2.

Small differences between the tidal heights presented by the charts in this paper and those predicted by conventional methods can be expected. These differences are mainly caused by the fact that

the conventional tidal predictions reference a point at the coast, often in harbors and estuaries, where the heights may be considerably affected by local conditions, i.e. local winds, river runoff, etc. Furthermore, the coarseness of the computational grid and accompanied inaccuracies in the reproduction of depths and coastlines caused some small differences. The conventional tide prediction methods do not allow for the computation of currents, as does the NH method.

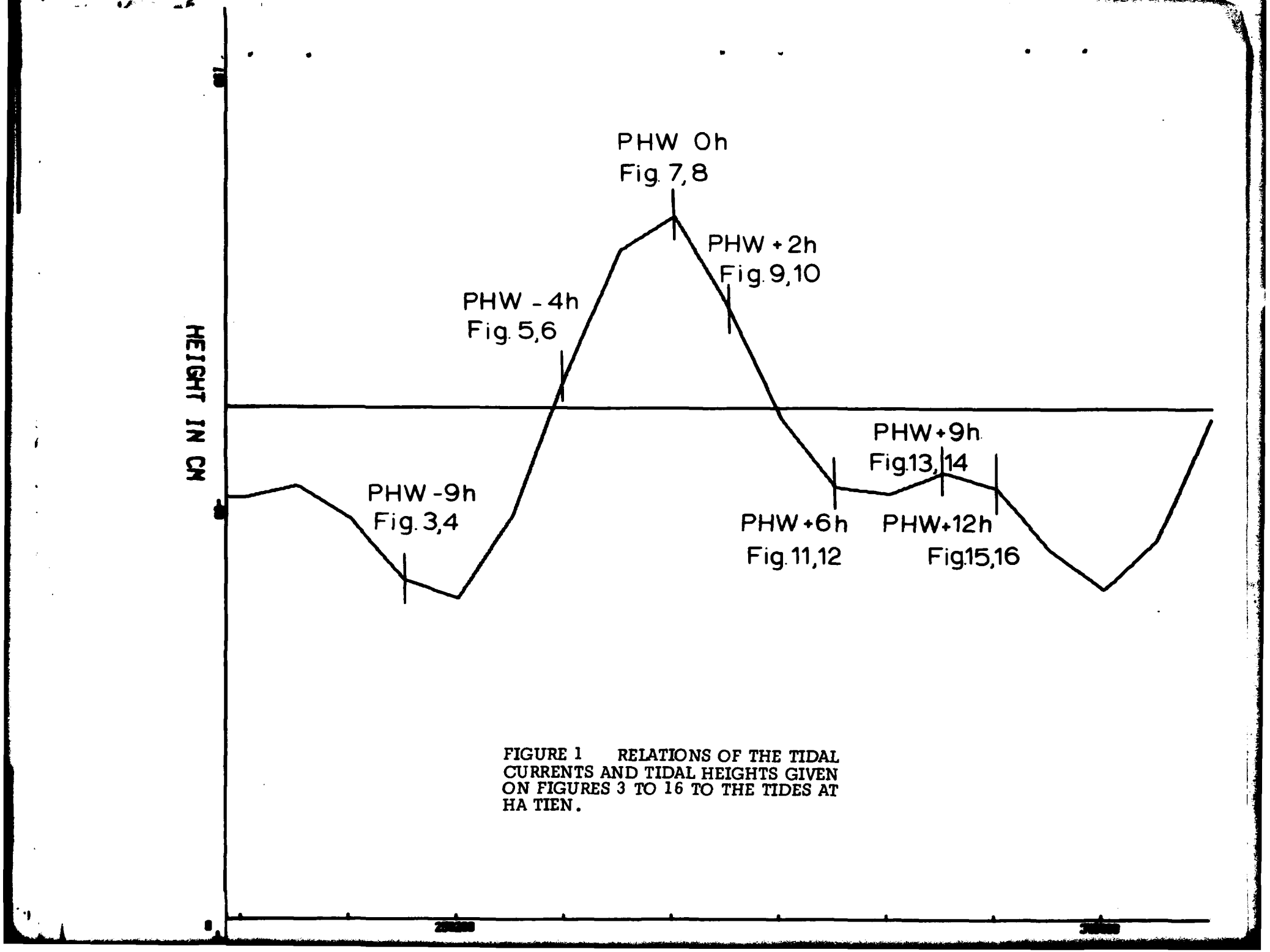

FIGURE 1 RELATIONS OF THE TIDAL CURRENTS AND TIDAL HEIGHTS GIVEN ON FIGURES 3 TO 16 TO THE TIDES AT HA TIEN.

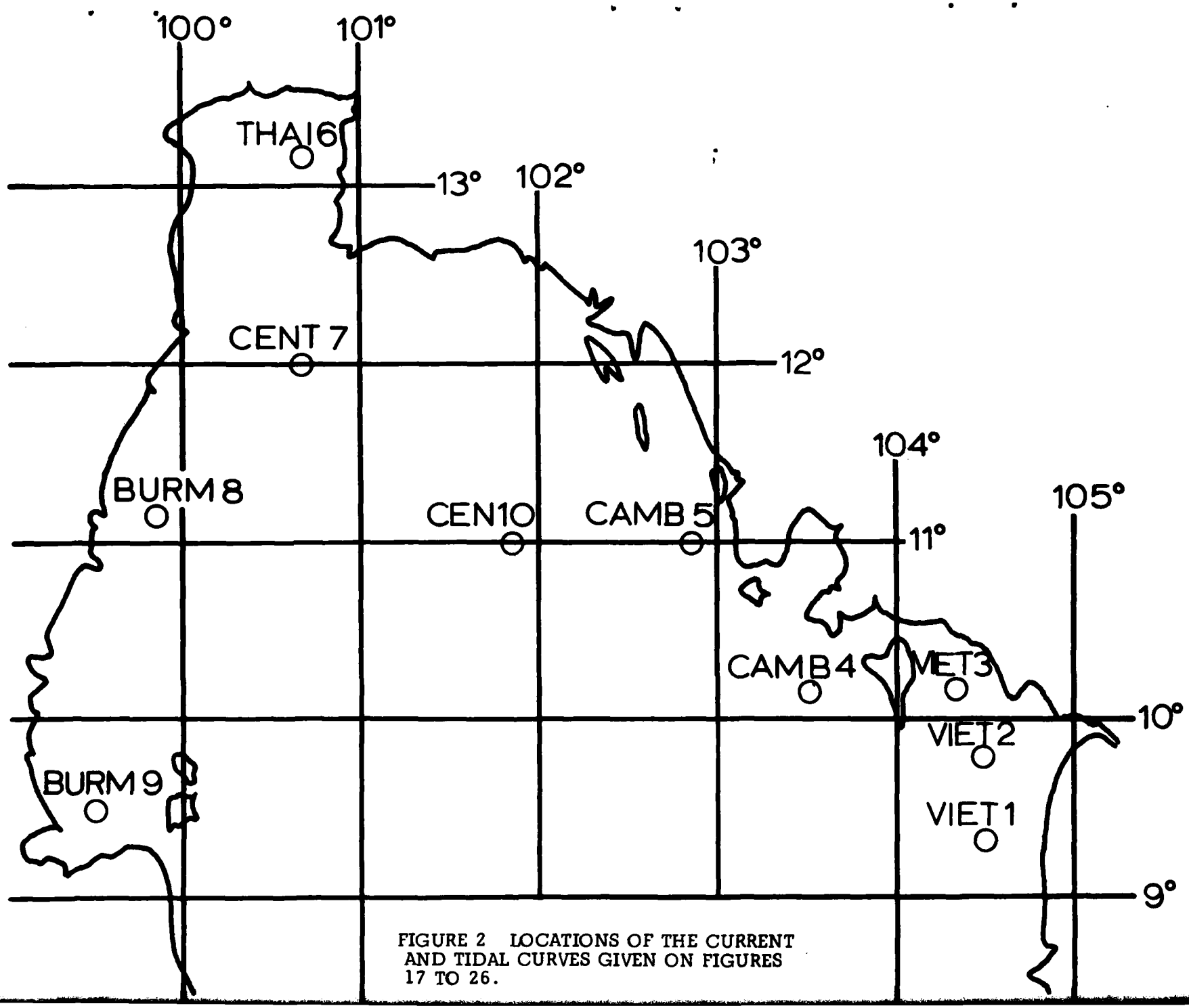

FIGURE 2 LOCATIONS OF THE CURRENT AND TIDAL CURVES GIVEN ON FIGURES 17 TO 26.

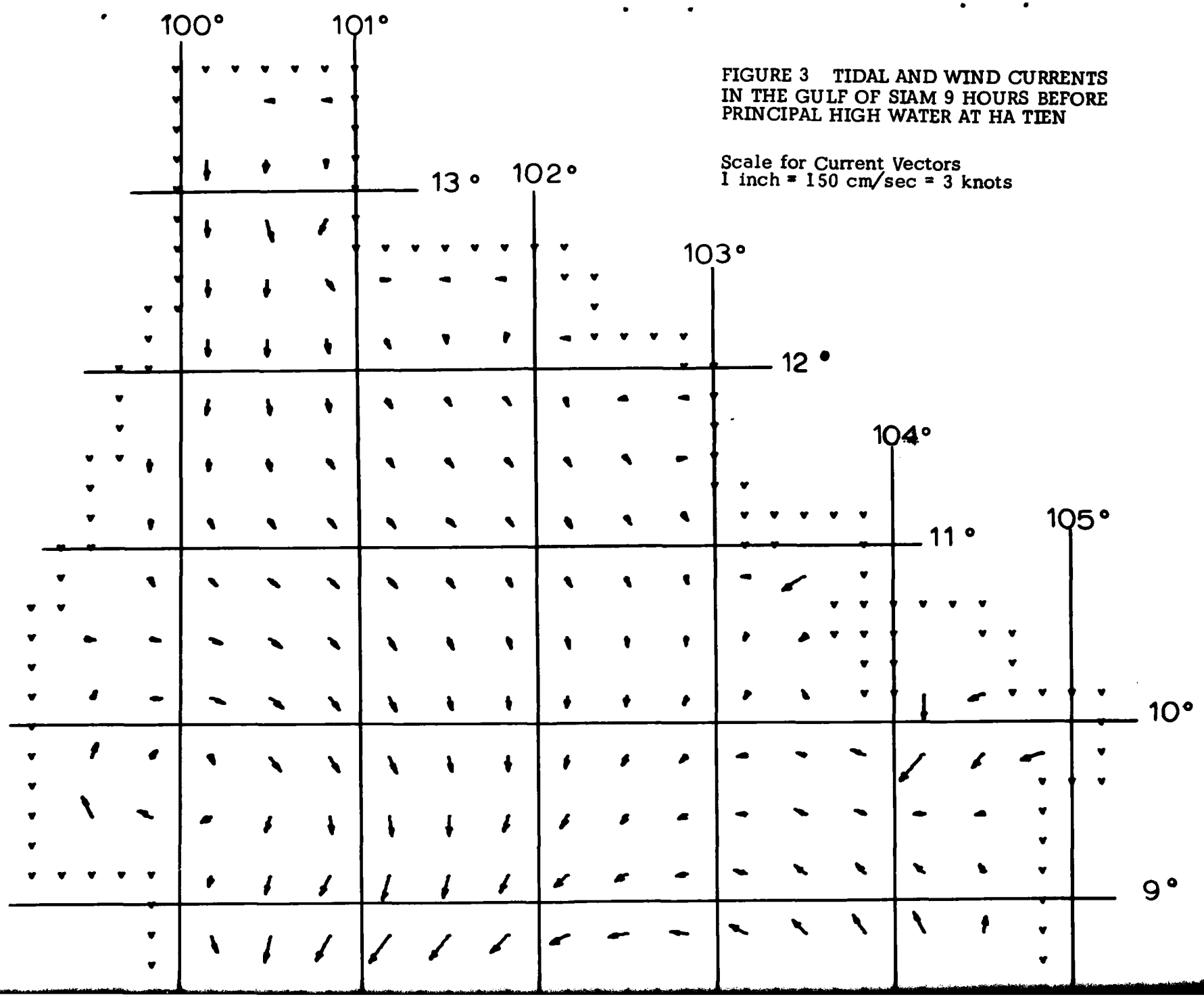

FIGURE 3 TIDAL AND WIND CURRENTS IN THE GULF OF SIAM 9 HOURS BEFORE PRINCIPAL HIGH WATER AT HA TIEN

Scale for Current Vectors
1 inch = 150 cm/sec = 3 knots

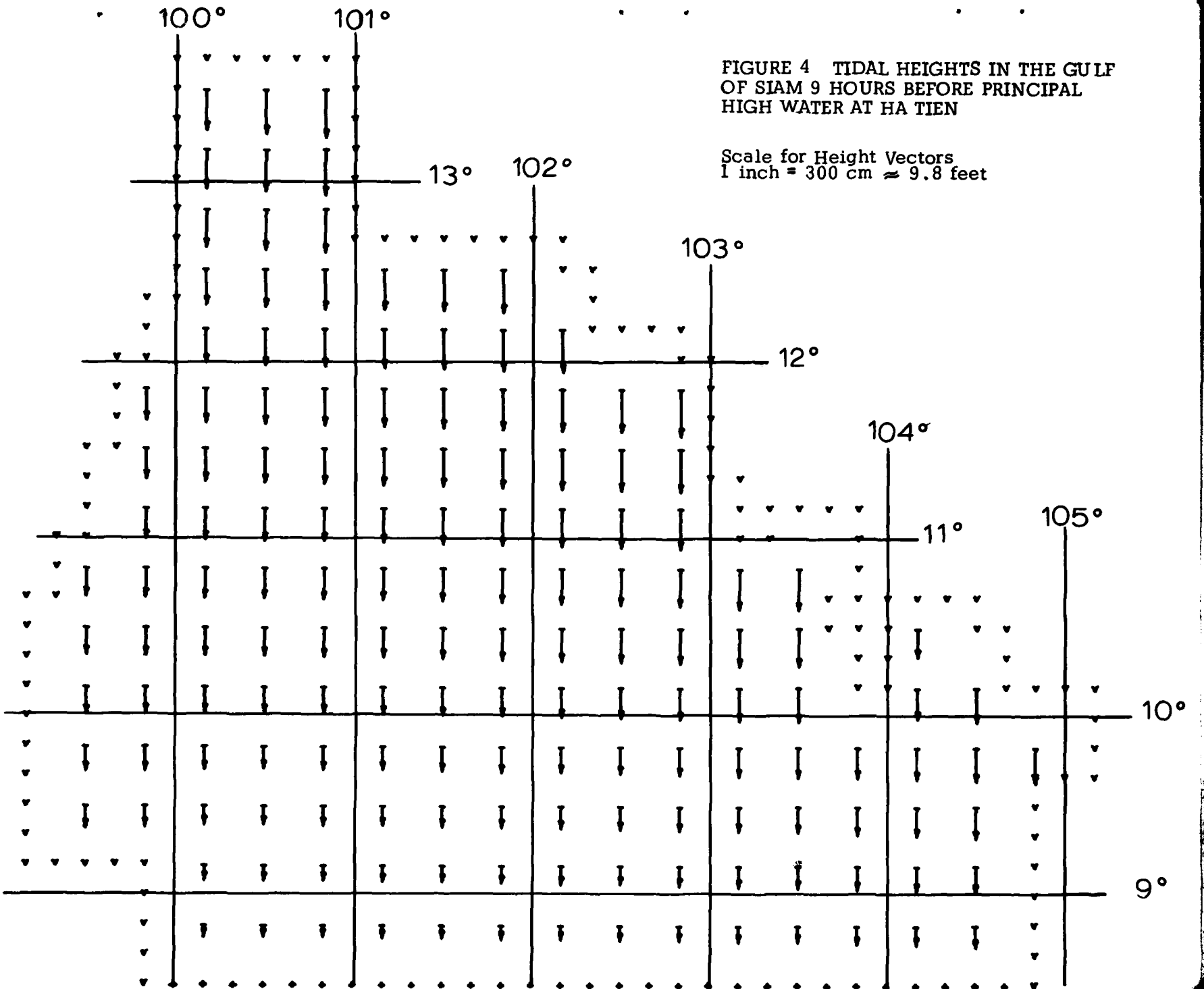

FIGURE 4 TIDAL HEIGHTS IN THE GULF OF SIAM 9 HOURS BEFORE PRINCIPAL HIGH WATER AT HA TIEN

Scale for Height Vectors
1 inch = 300 cm ≈ 9.8 feet

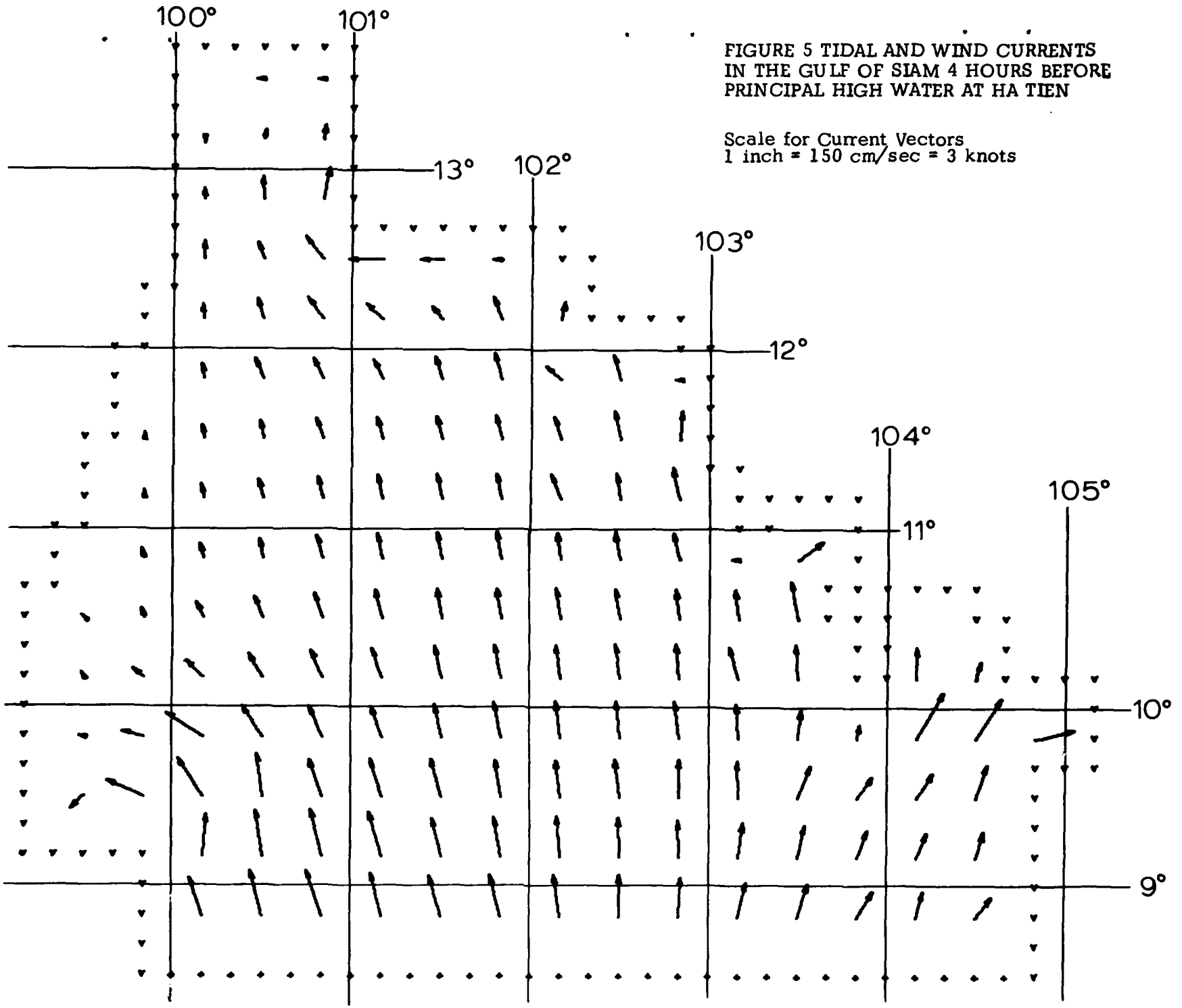

FIGURE 5 TIDAL AND WIND CURRENTS IN THE GULF OF SIAM 4 HOURS BEFORE PRINCIPAL HIGH WATER AT HA TIEN

Scale for Current Vectors
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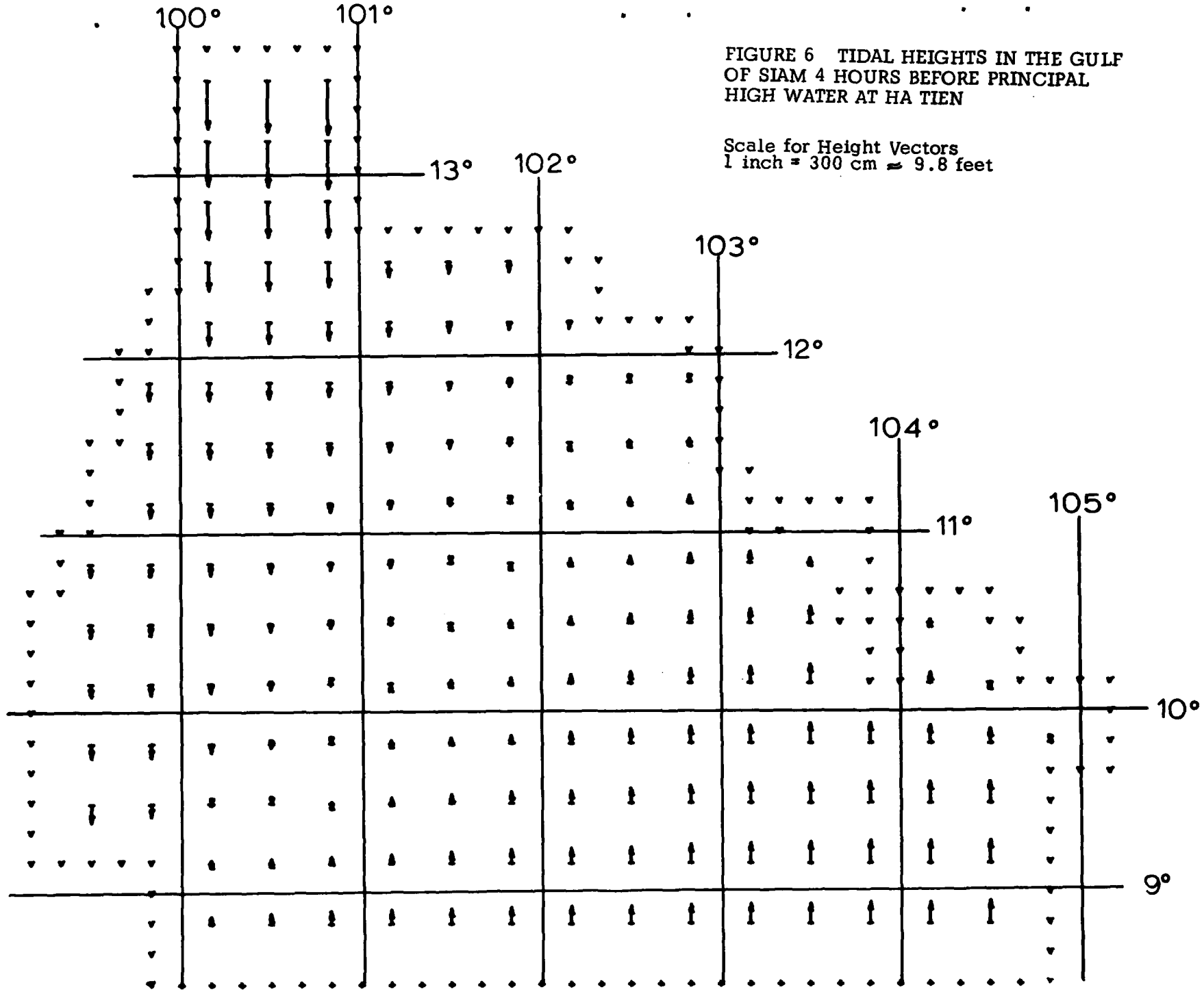

FIGURE 6 TIDAL HEIGHTS IN THE GULF OF SIAM 4 HOURS BEFORE PRINCIPAL HIGH WATER AT HA TIEN

Scale for Height Vectors
1 inch = 300 cm ≈ 9.8 feet

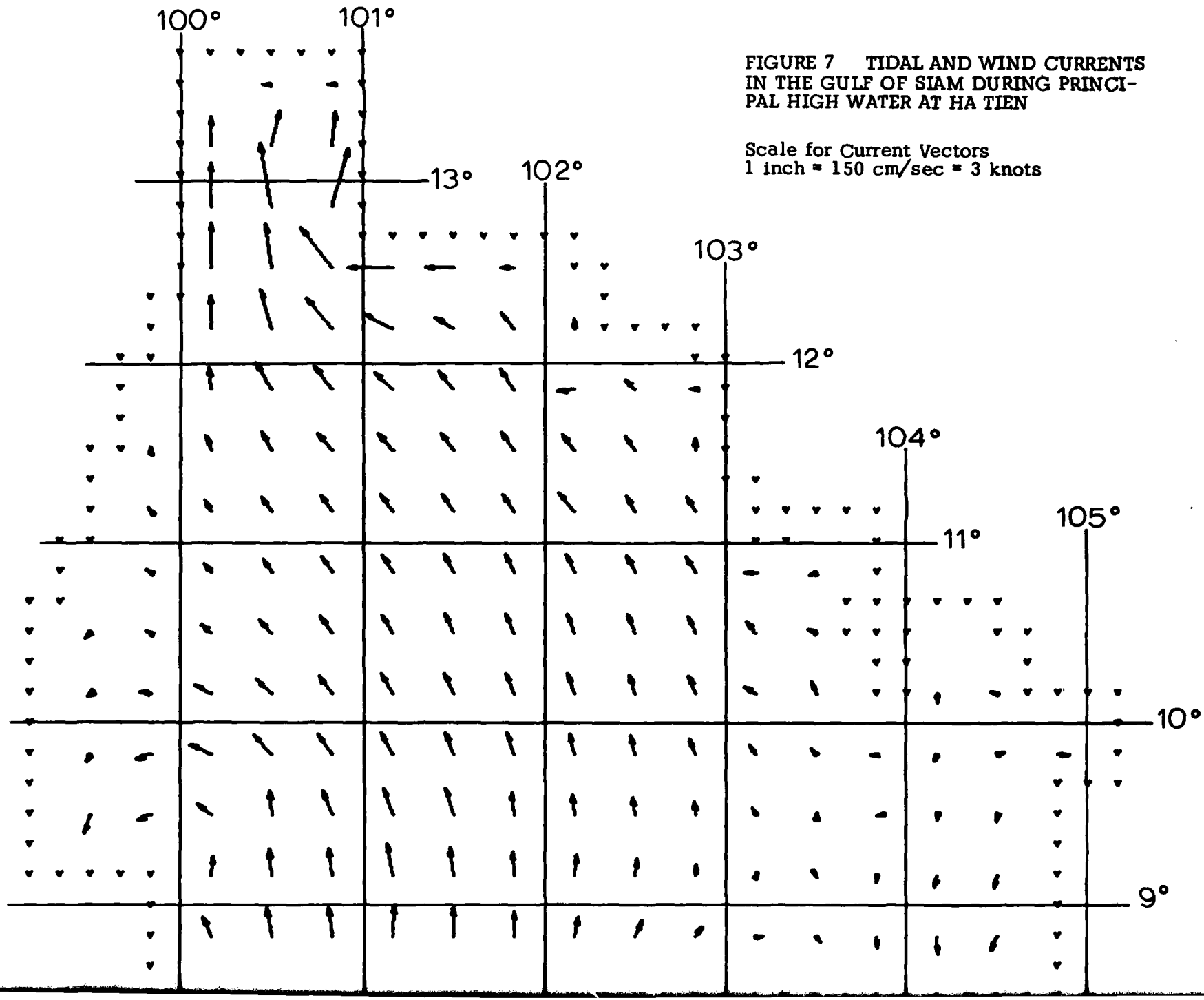

FIGURE 7 TIDAL AND WIND CURRENTS IN THE GULF OF SIAM DURING PRINCIPAL HIGH WATER AT HA TIEN

Scale for Current Vectors
1 inch = 150 cm/sec = 3 knots

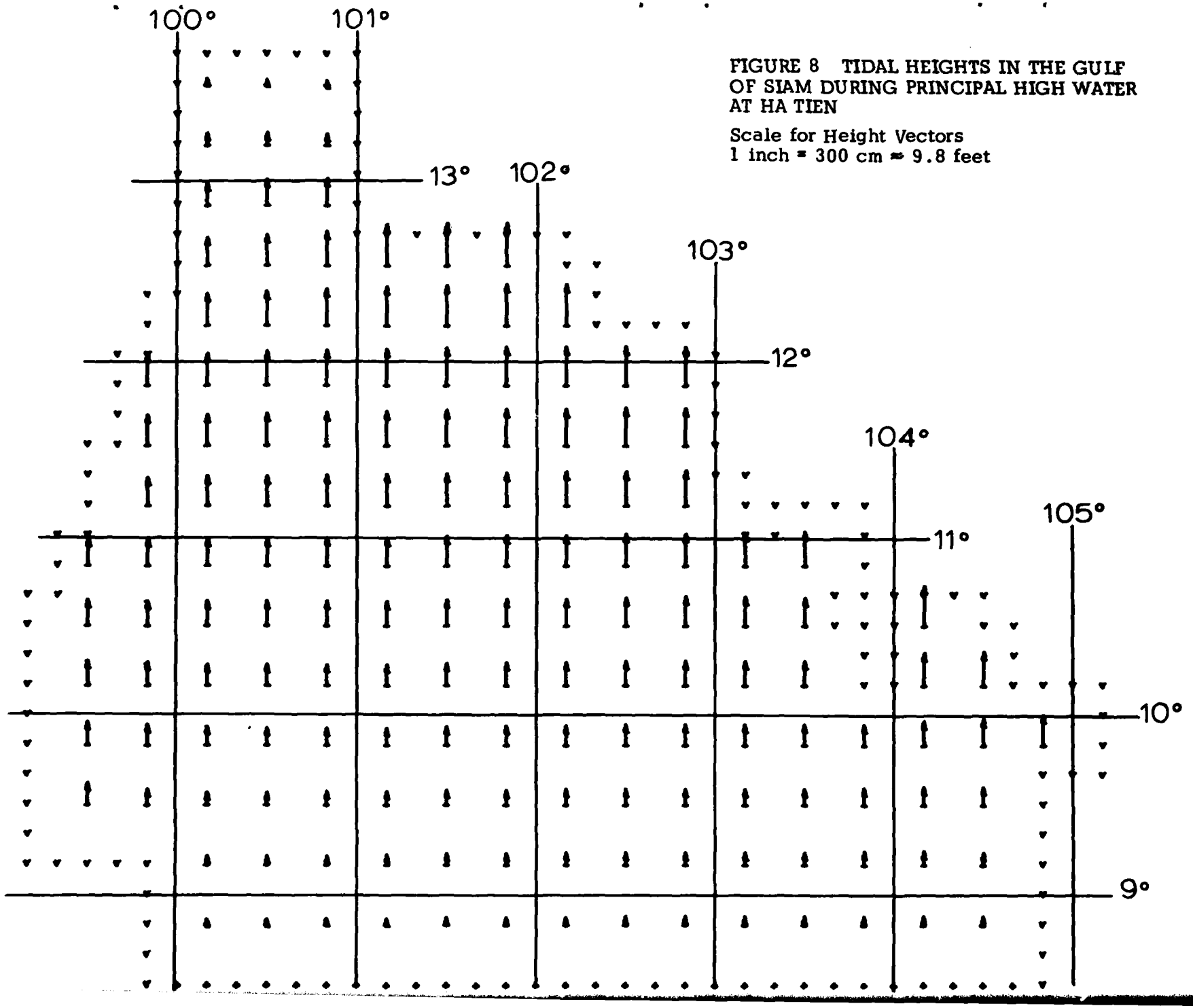

FIGURE 8 TIDAL HEIGHTS IN THE GULF OF SIAM DURING PRINCIPAL HIGH WATER AT HA TIEN

Scale for Height Vectors
1 inch = 300 cm ≈ 9.8 feet

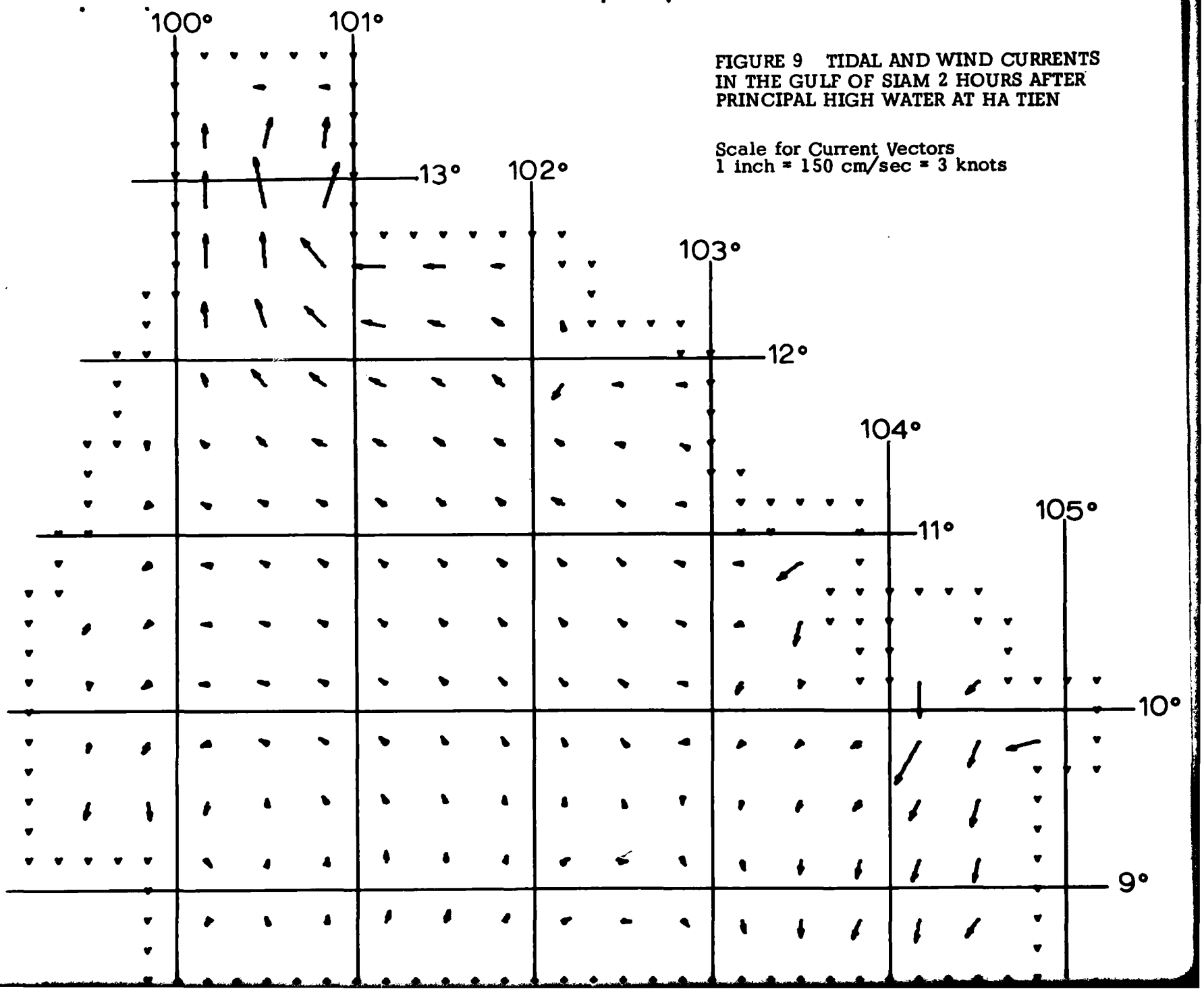

FIGURE 9 TIDAL AND WIND CURRENTS IN THE GULF OF SIAM 2 HOURS AFTER PRINCIPAL HIGH WATER AT HA TIEN

Scale for Current Vectors
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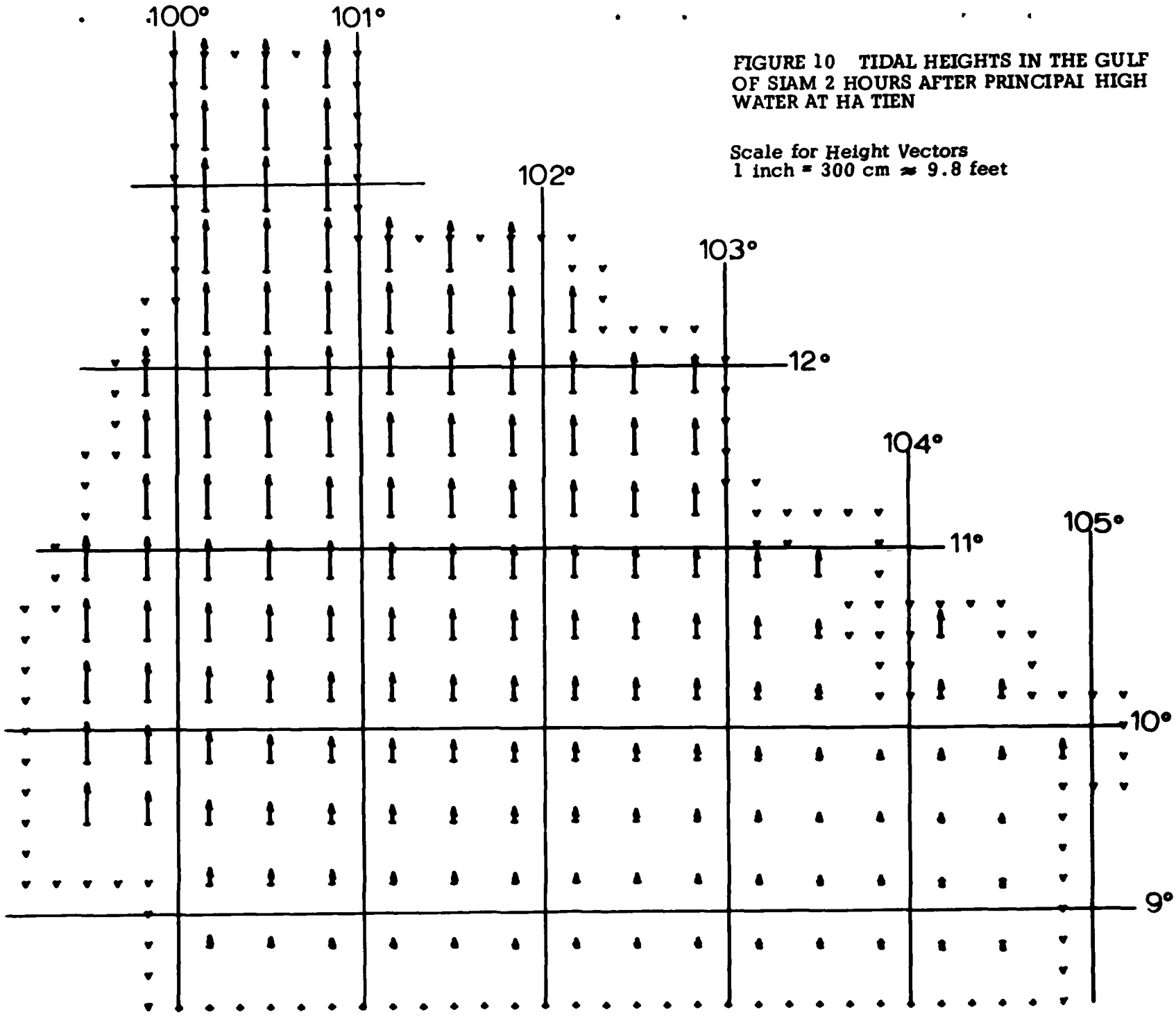

FIGURE 10 TIDAL HEIGHTS IN THE GULF OF SIAM 2 HOURS AFTER PRINCIPAI HIGH WATER AT HA TIEN

Scale for Height Vectors
1 inch = 300 cm ≈ 9.8 feet

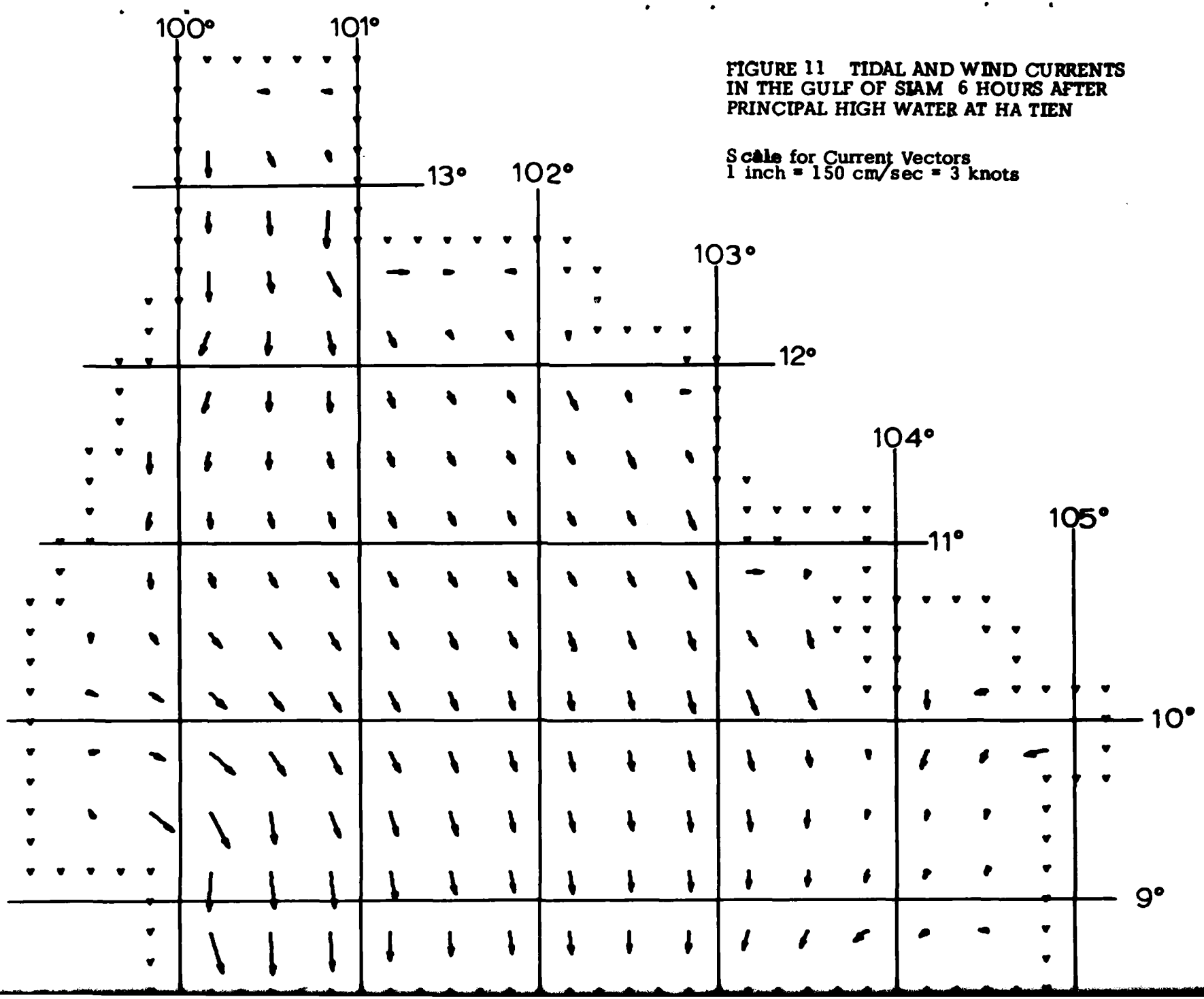

FIGURE 11 TIDAL AND WIND CURRENTS IN THE GULF OF SIAM 6 HOURS AFTER PRINCIPAL HIGH WATER AT HA TIEN

Scale for Current Vectors
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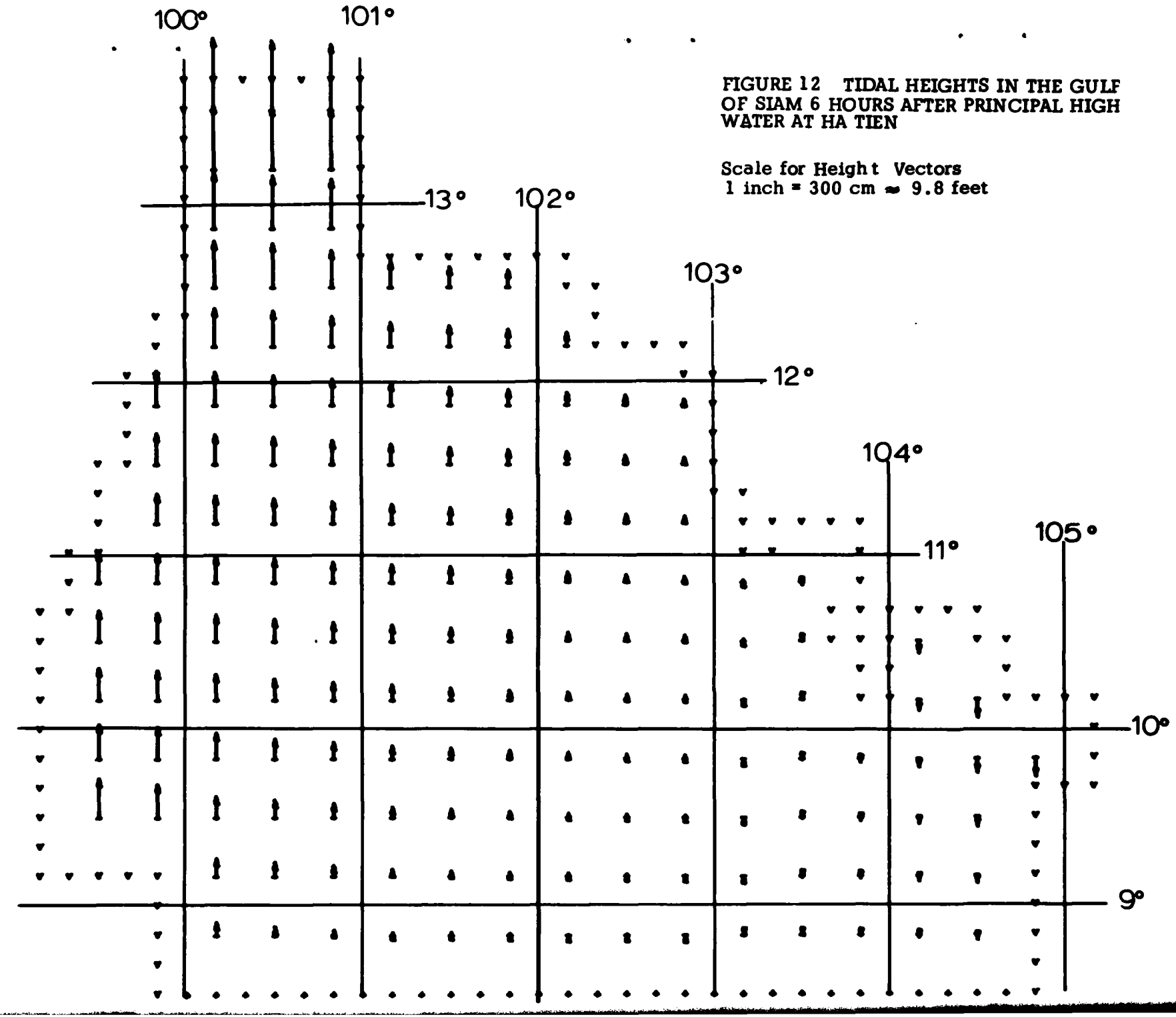

FIGURE 12 TIDAL HEIGHTS IN THE GULF OF SIAM 6 HOURS AFTER PRINCIPAL HIGH WATER AT HA TIEN

Scale for Height Vectors
1 inch = 300 cm ≈ 9.8 feet

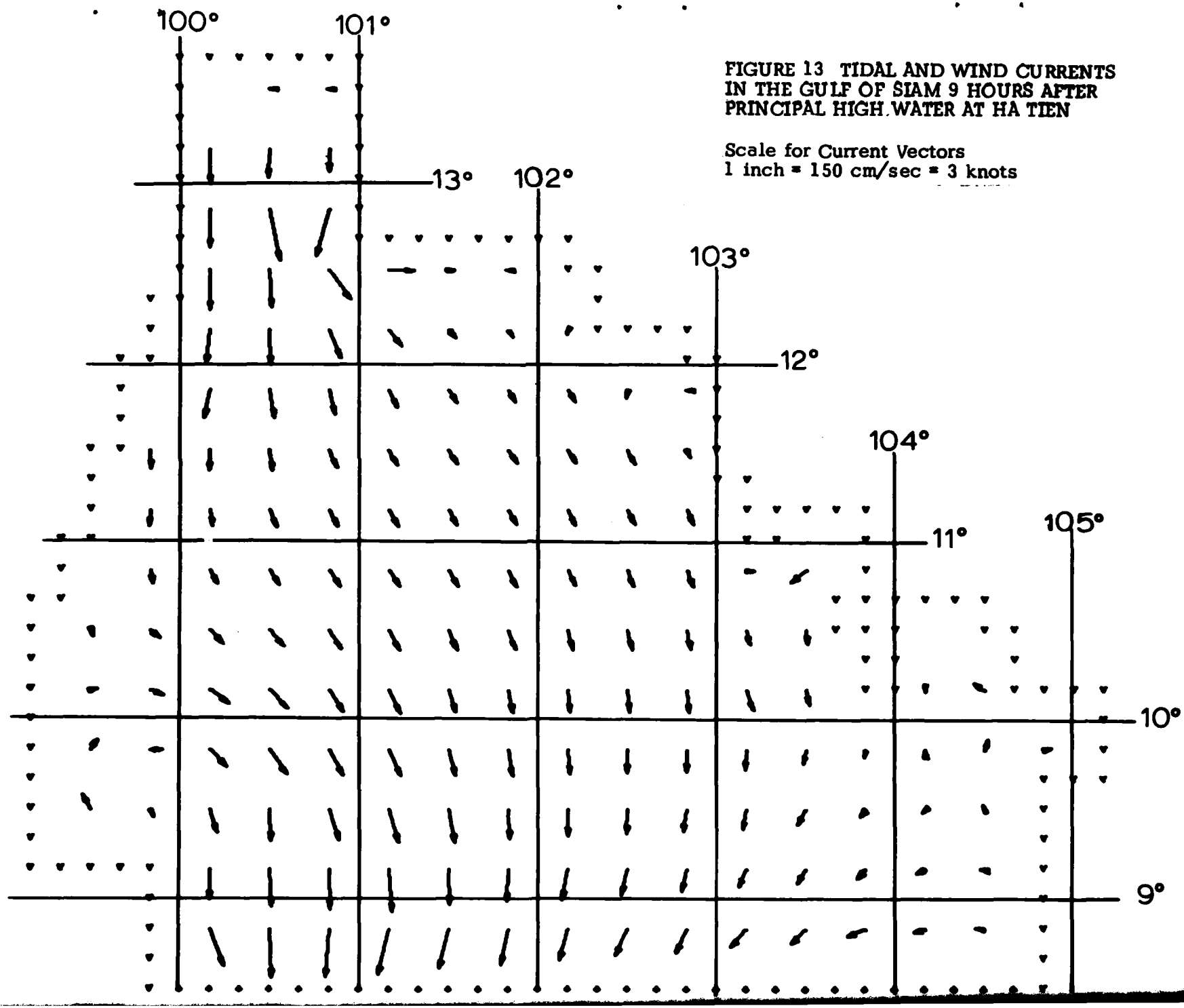

FIGURE 13 TIDAL AND WIND CURRENTS IN THE GULF OF SIAM 9 HOURS AFTER PRINCIPAL HIGH WATER AT HA TIEN

Scale for Current Vectors
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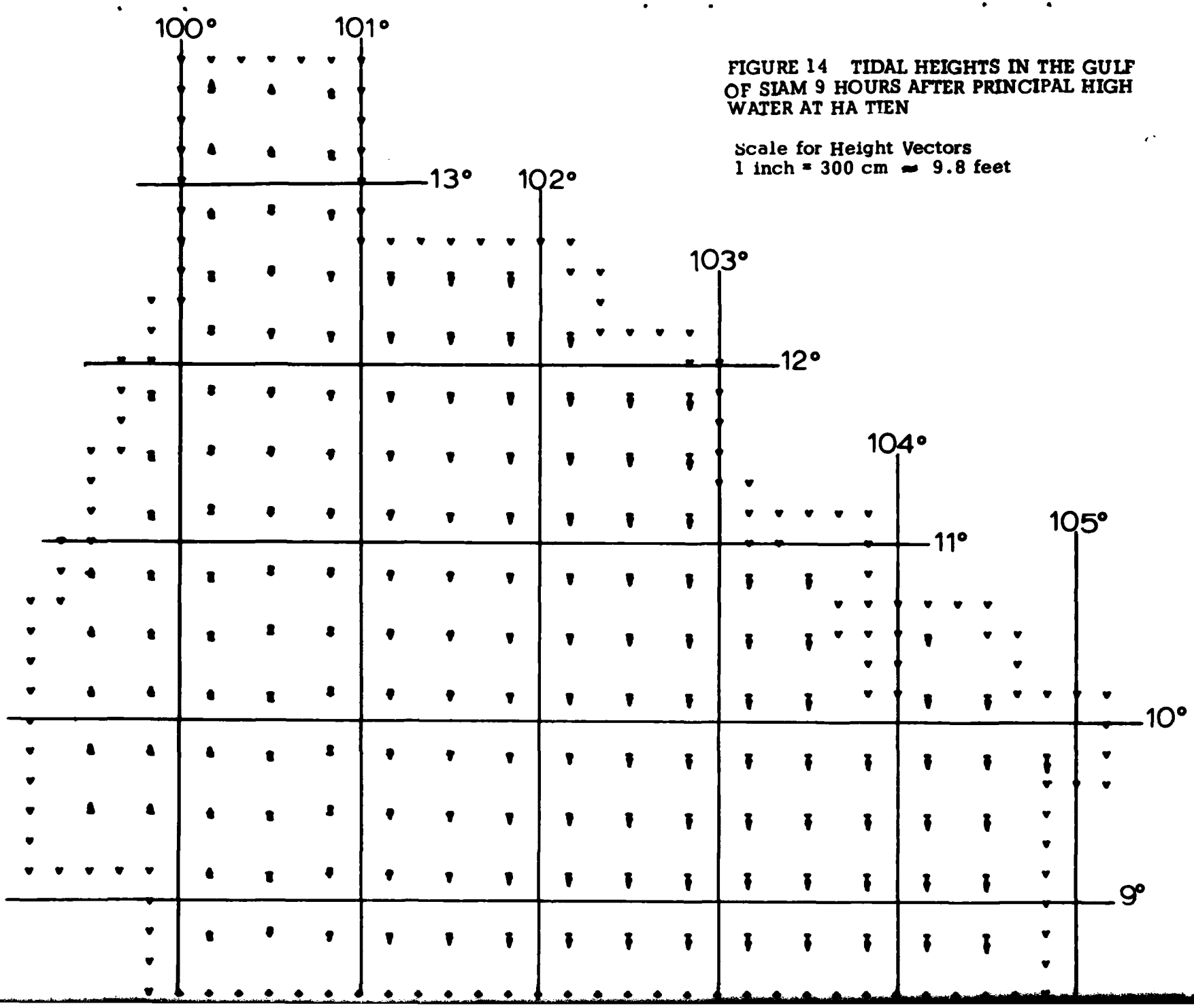

FIGURE 14 TIDAL HEIGHTS IN THE GULF OF SIAM 9 HOURS AFTER PRINCIPAL HIGH WATER AT HA TIEN

Scale for Height Vectors
1 inch = 300 cm ≈ 9.8 feet

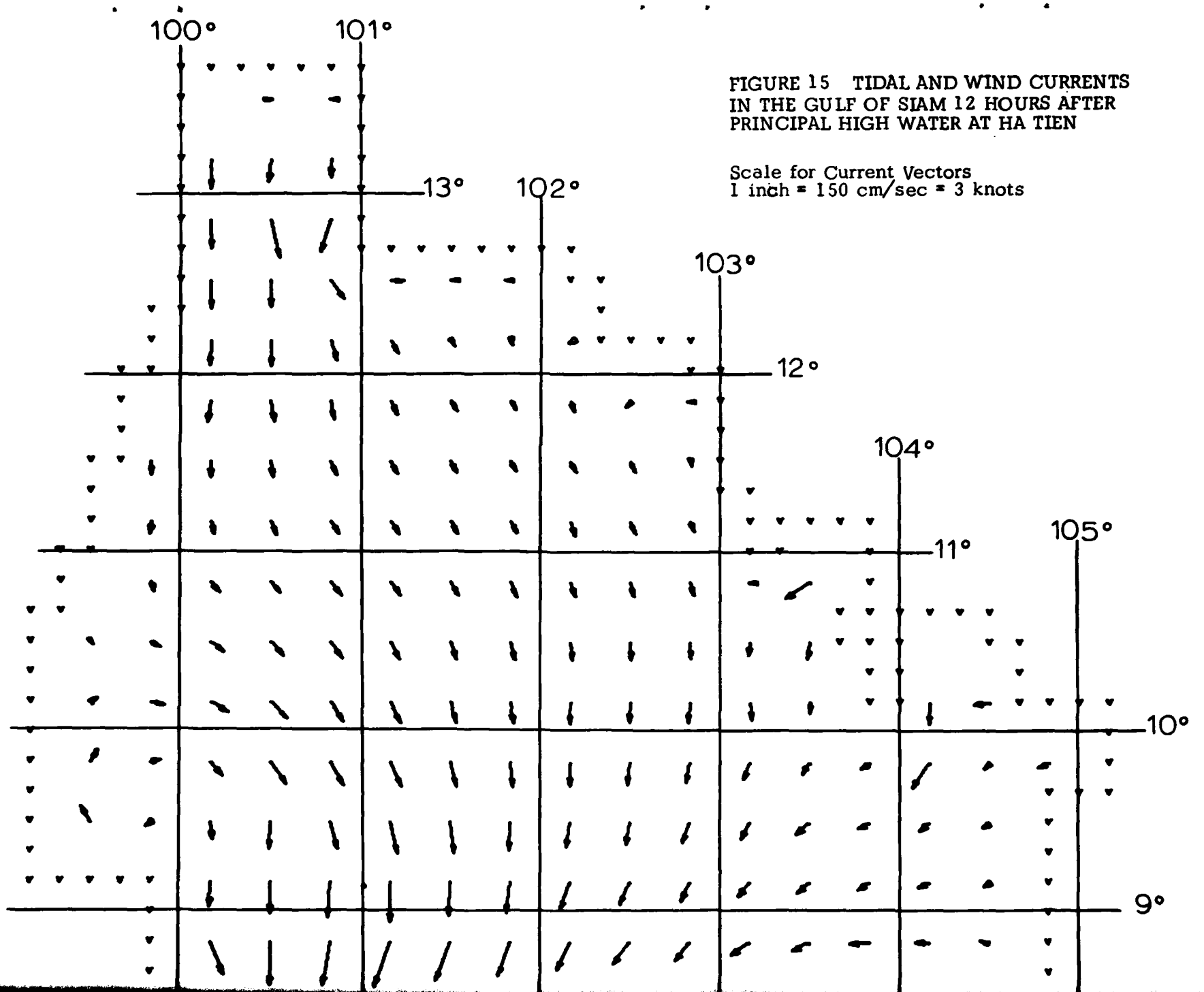

FIGURE 15 TIDAL AND WIND CURRENTS IN THE GULF OF SIAM 12 HOURS AFTER PRINCIPAL HIGH WATER AT HA TIEN

Scale for Current Vectors
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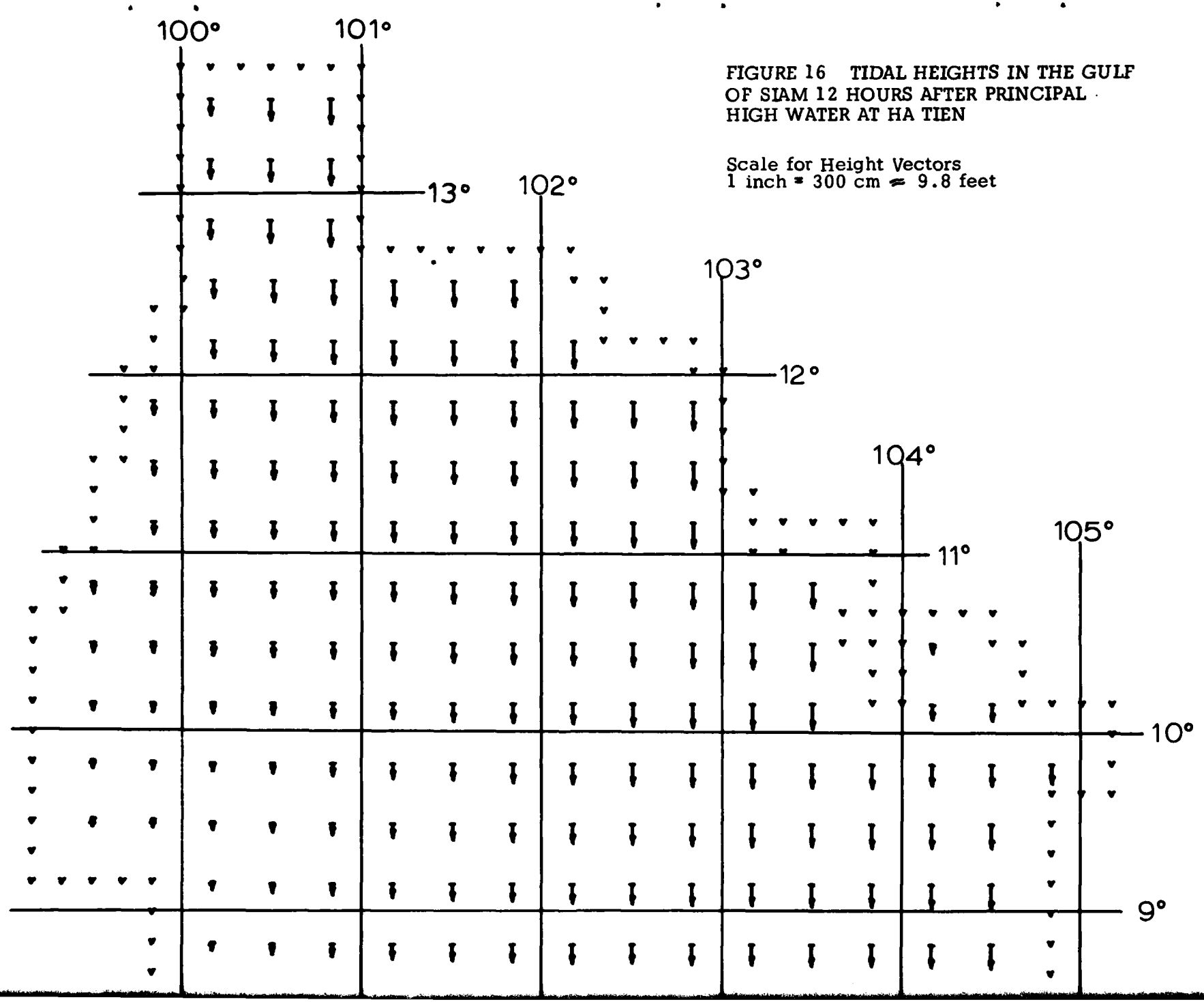

FIGURE 16 TIDAL HEIGHTS IN THE GULF OF SIAM 12 HOURS AFTER PRINCIPAL HIGH WATER AT HA TIEN

Scale for Height Vectors
1 inch = 300 cm ≈ 9.8 feet

FIGURE 17
VIET1

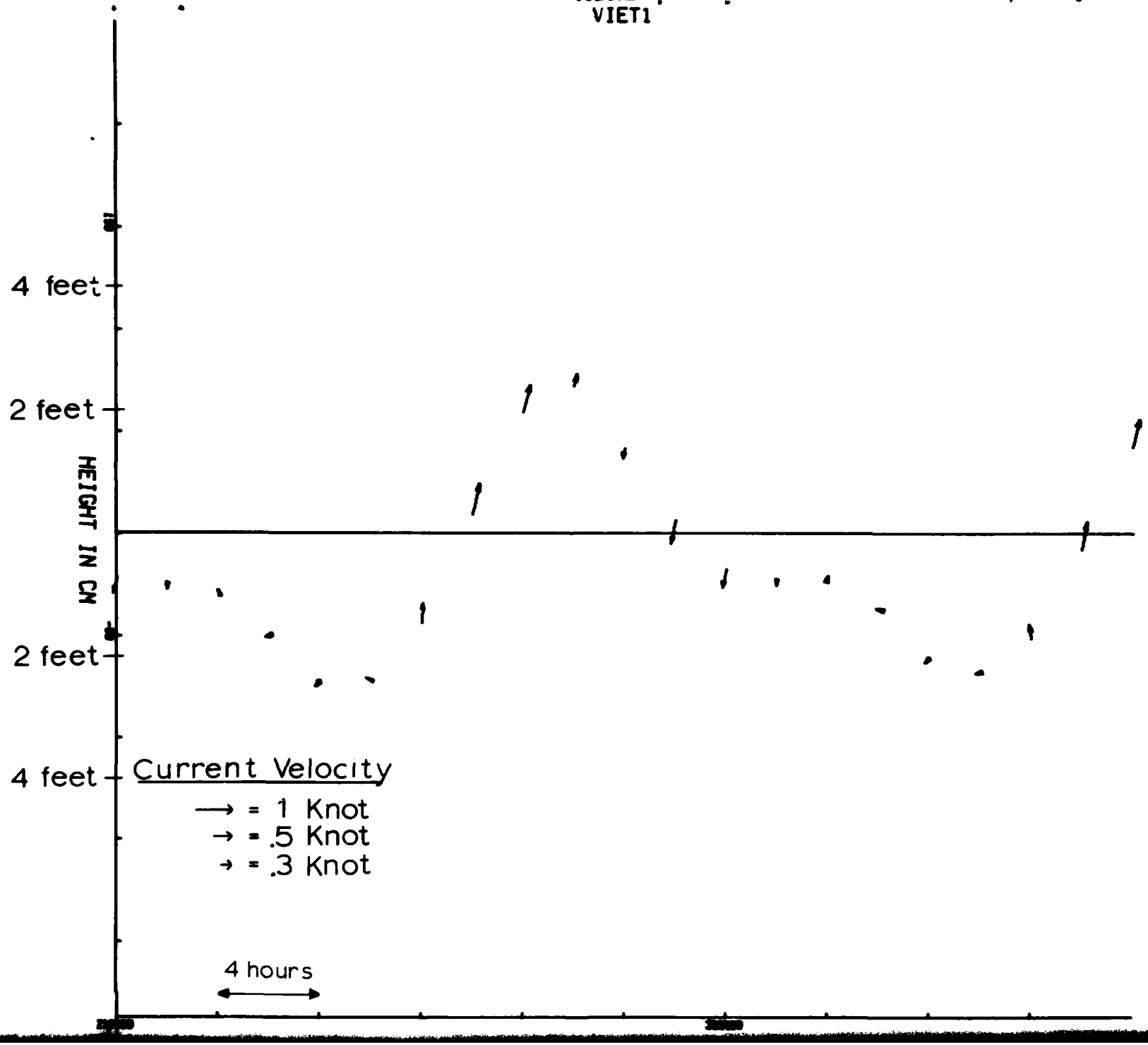

FIGURE 18
VIET2

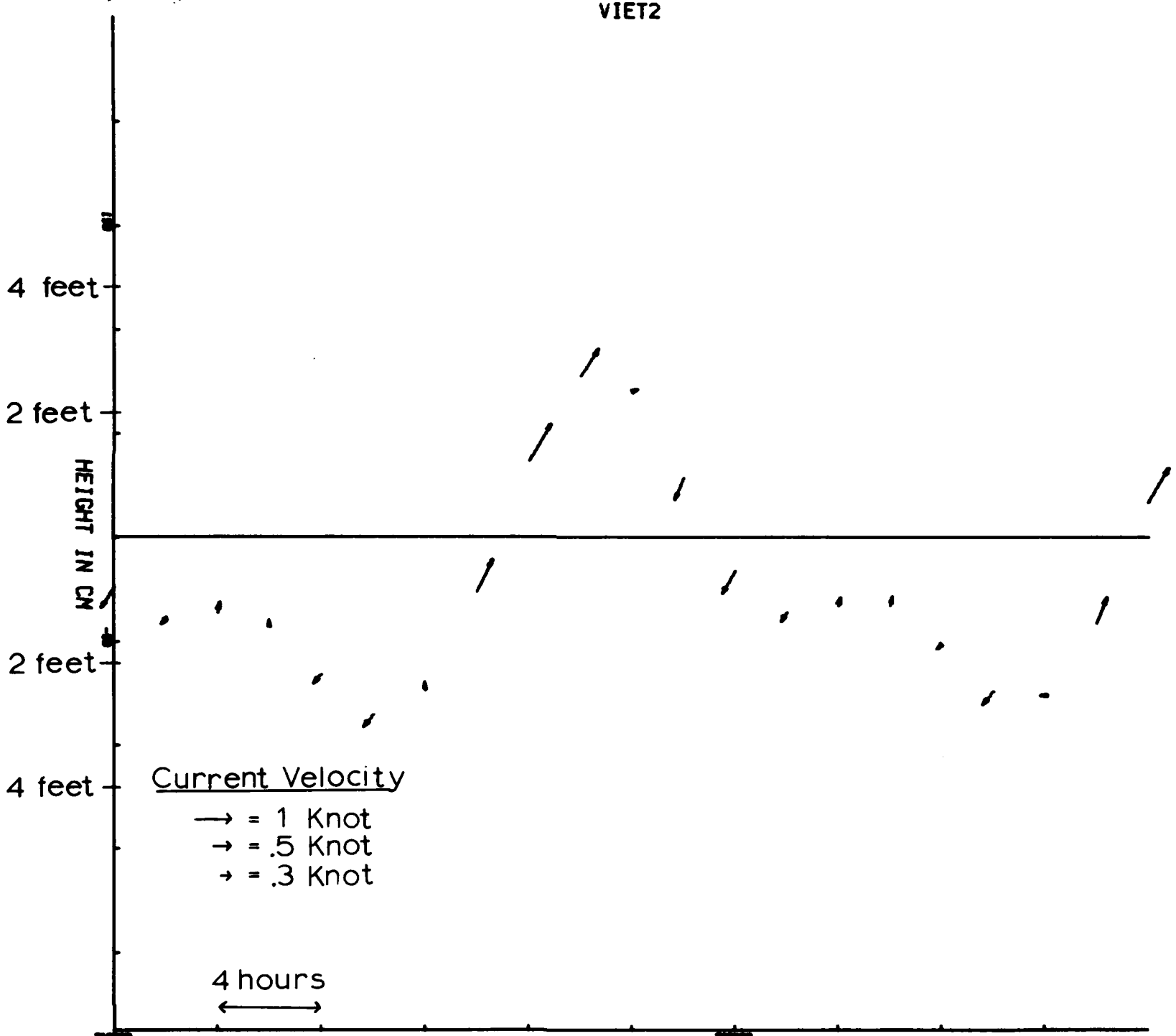

FIGURE 19
VIET3

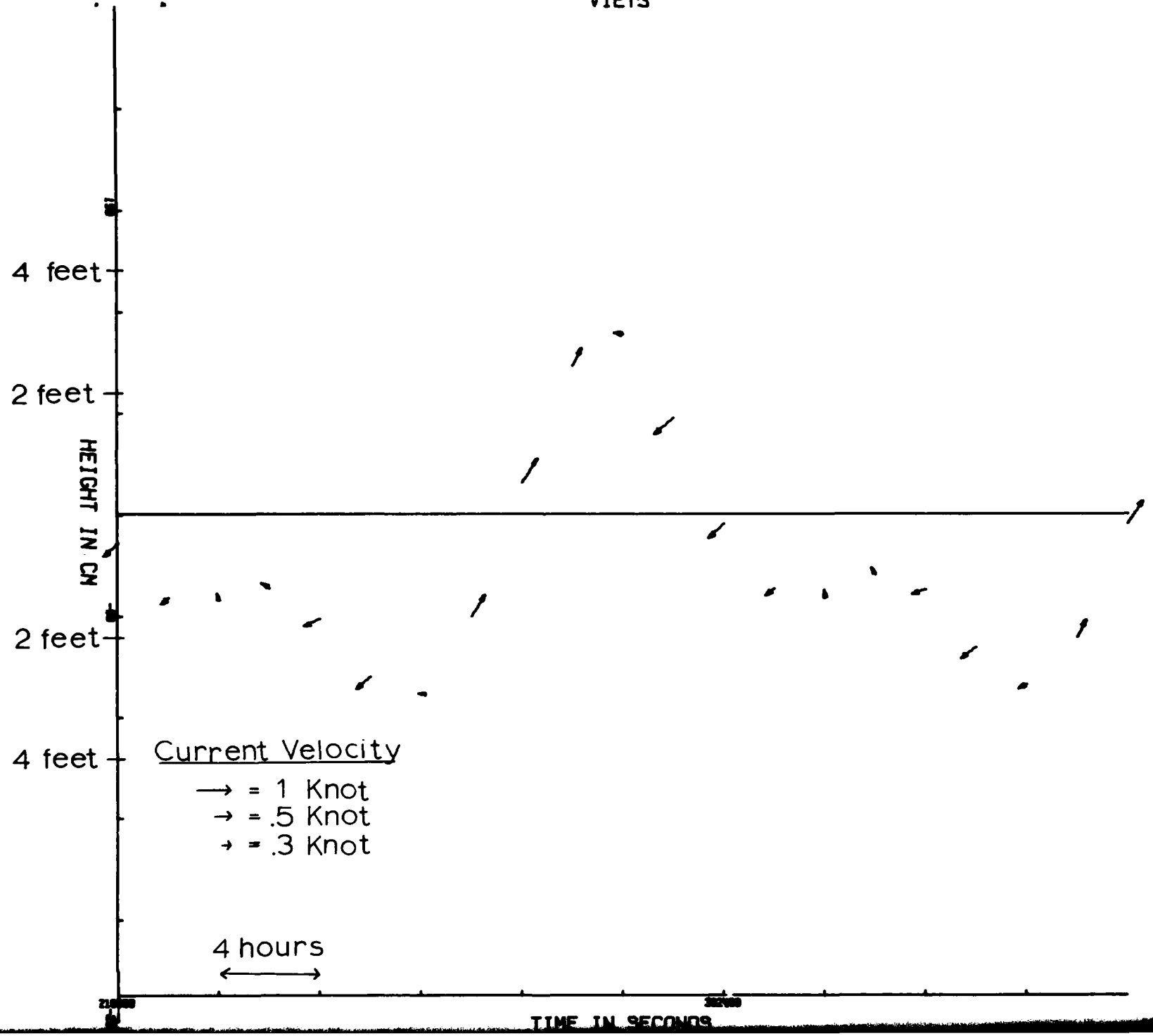

FIGURE 20
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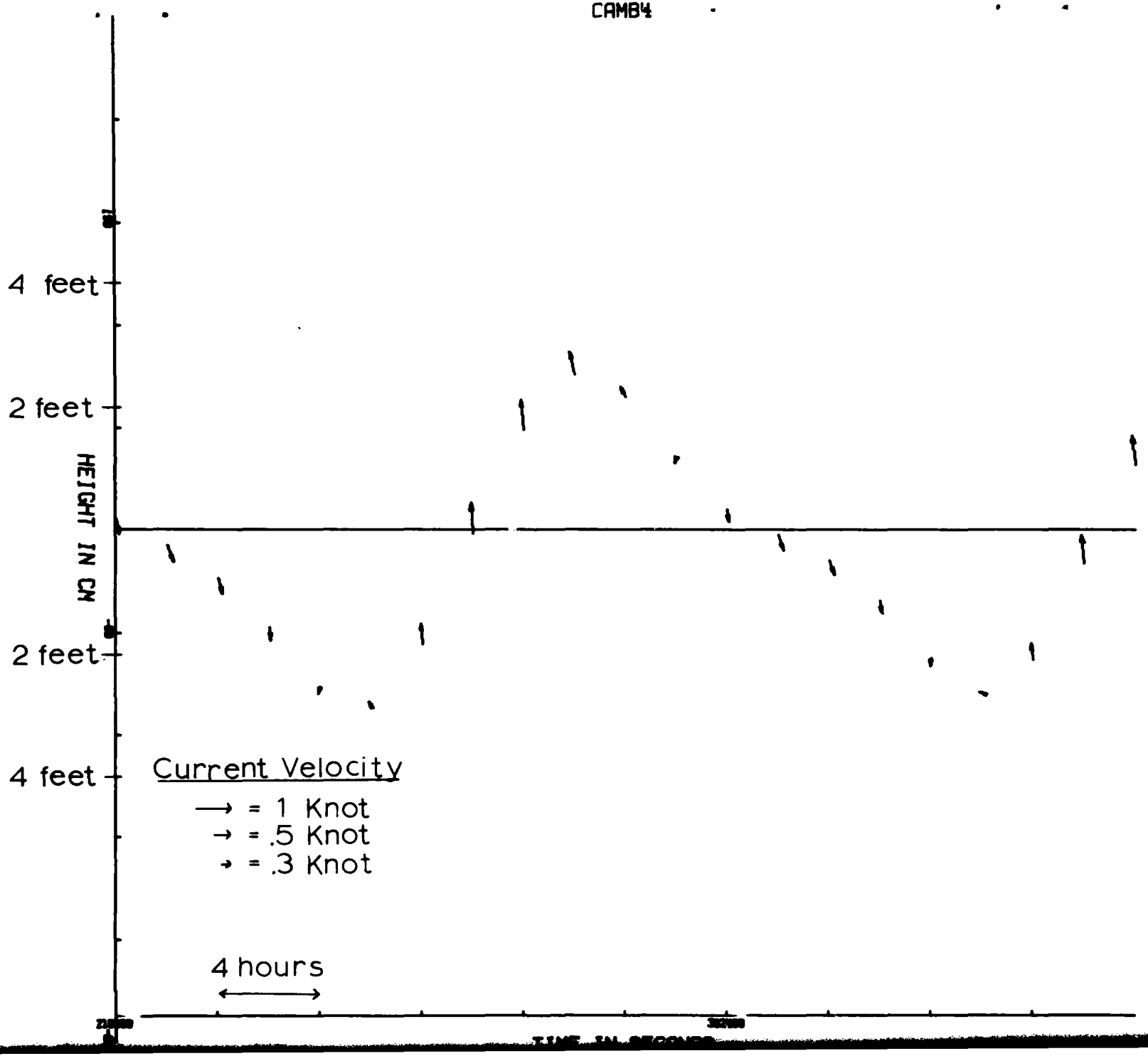

FIGURE 21
CAMBS

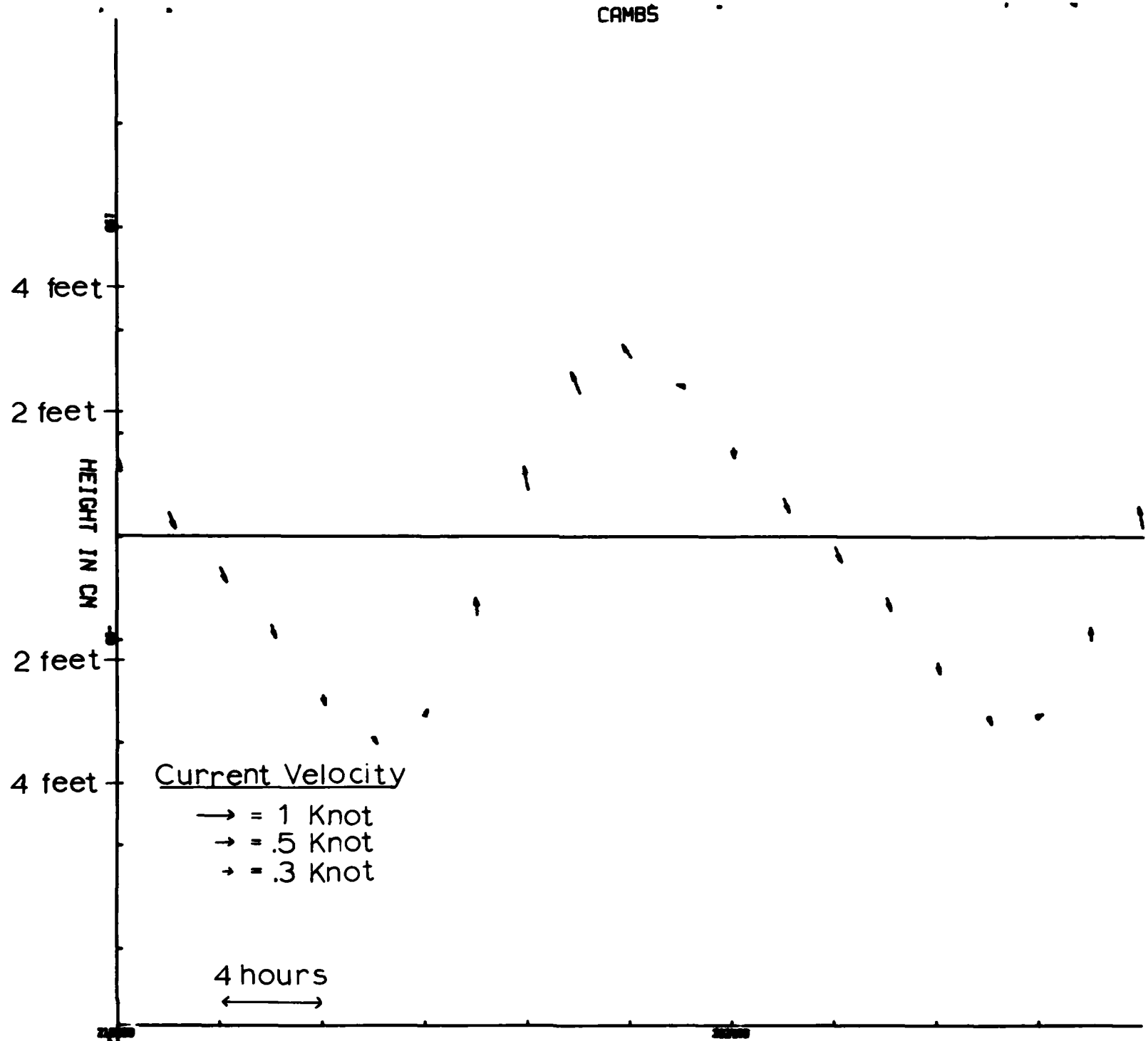

FIGURE 22
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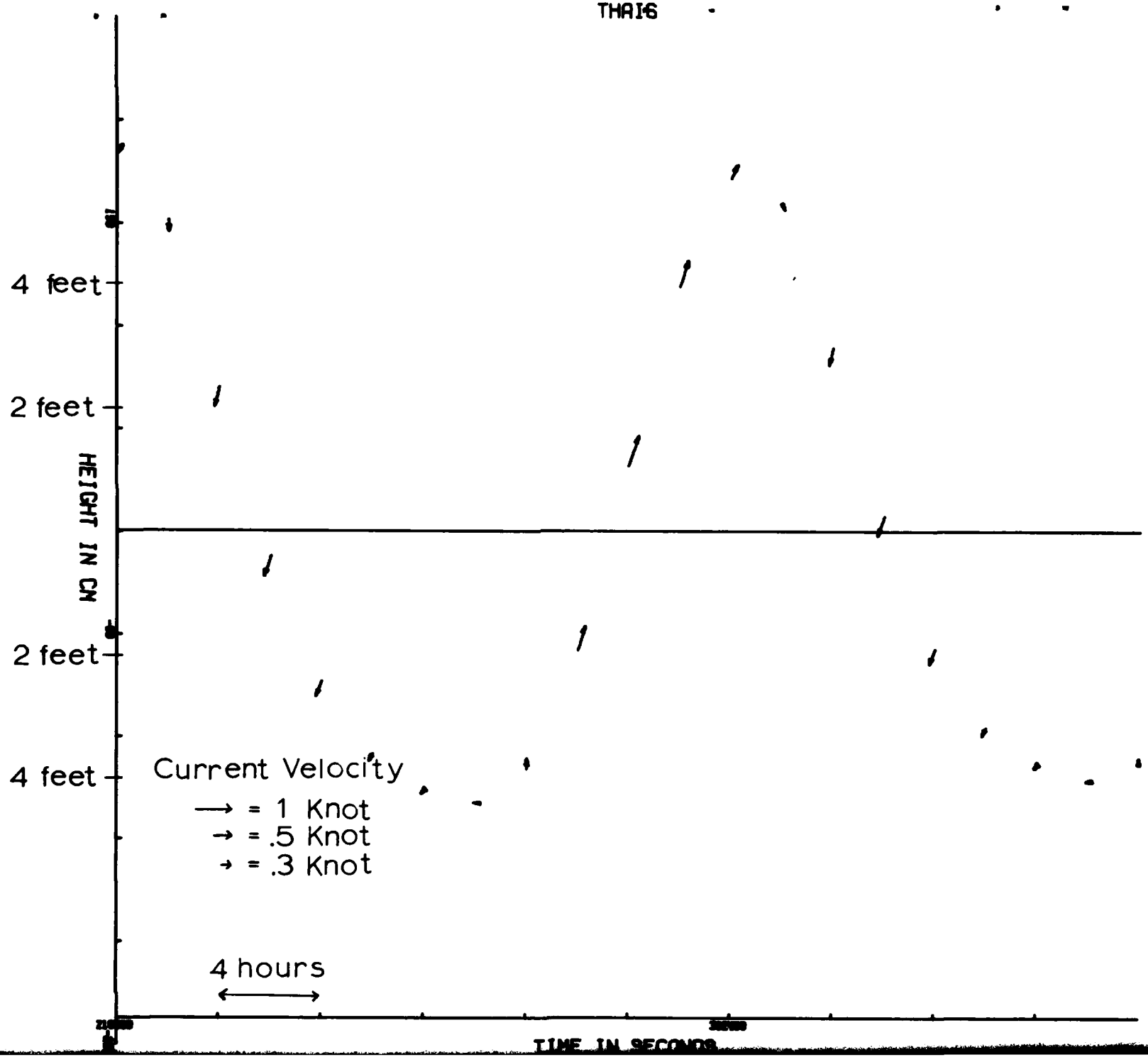

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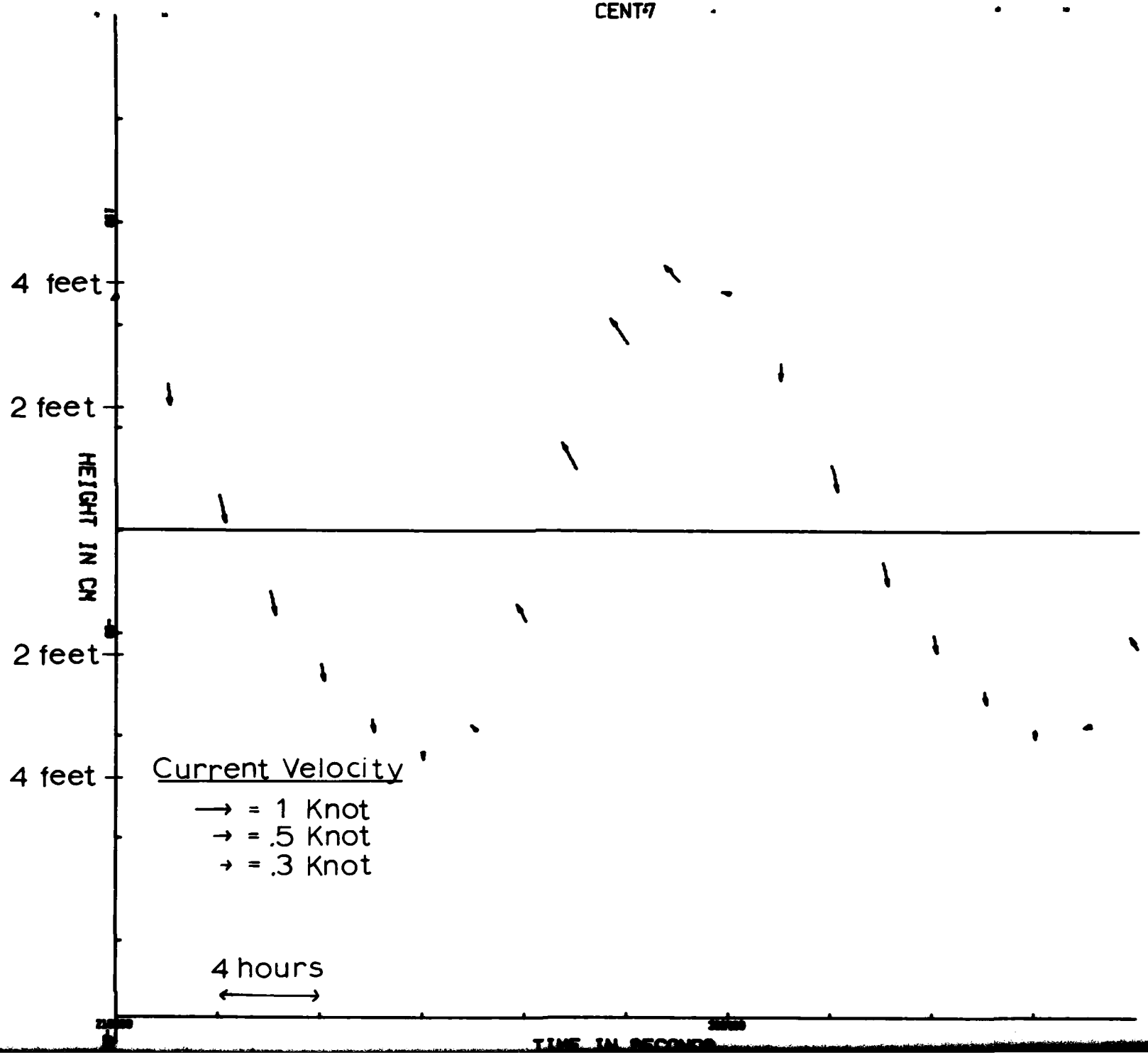

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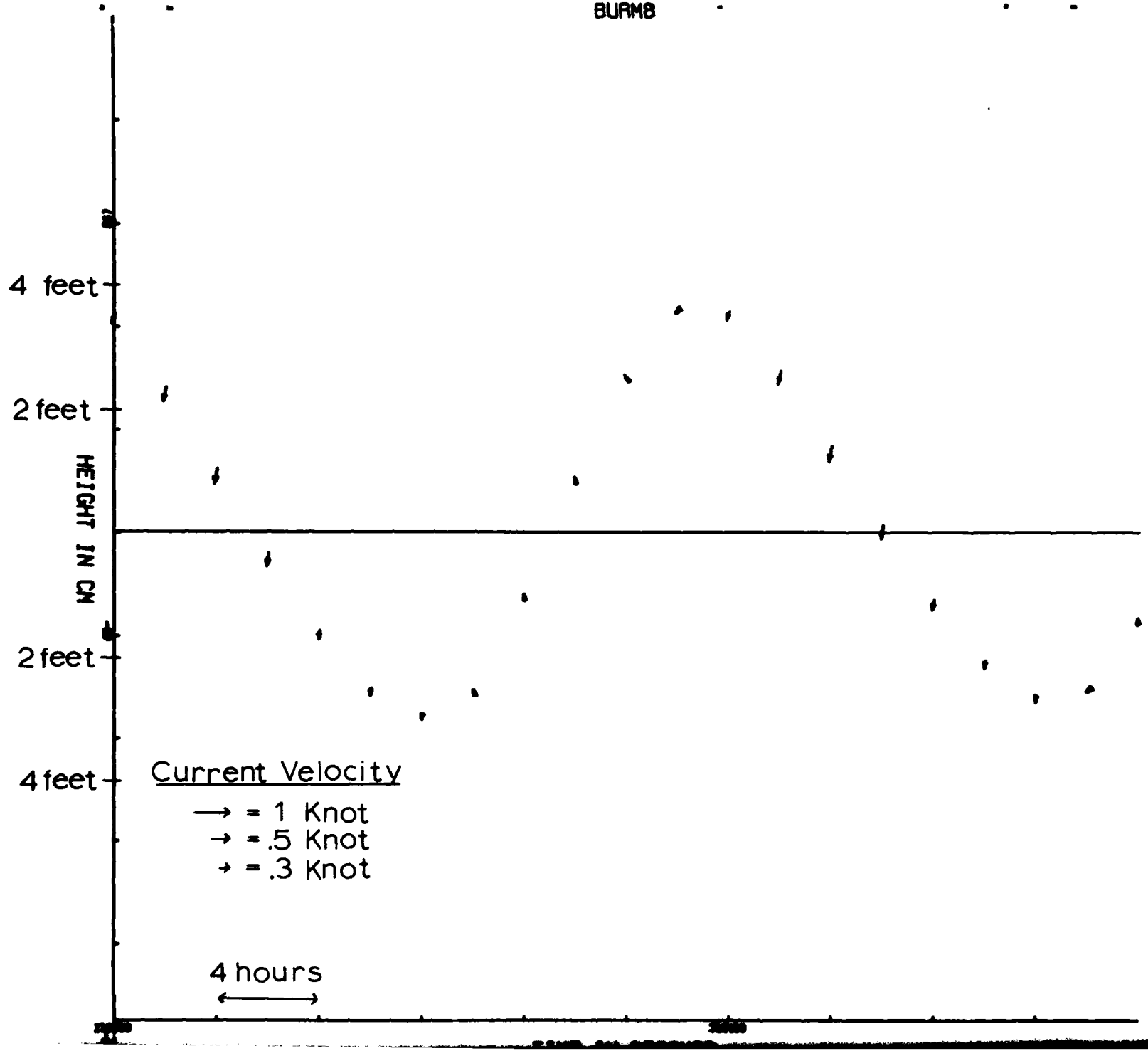

FIGURE 25
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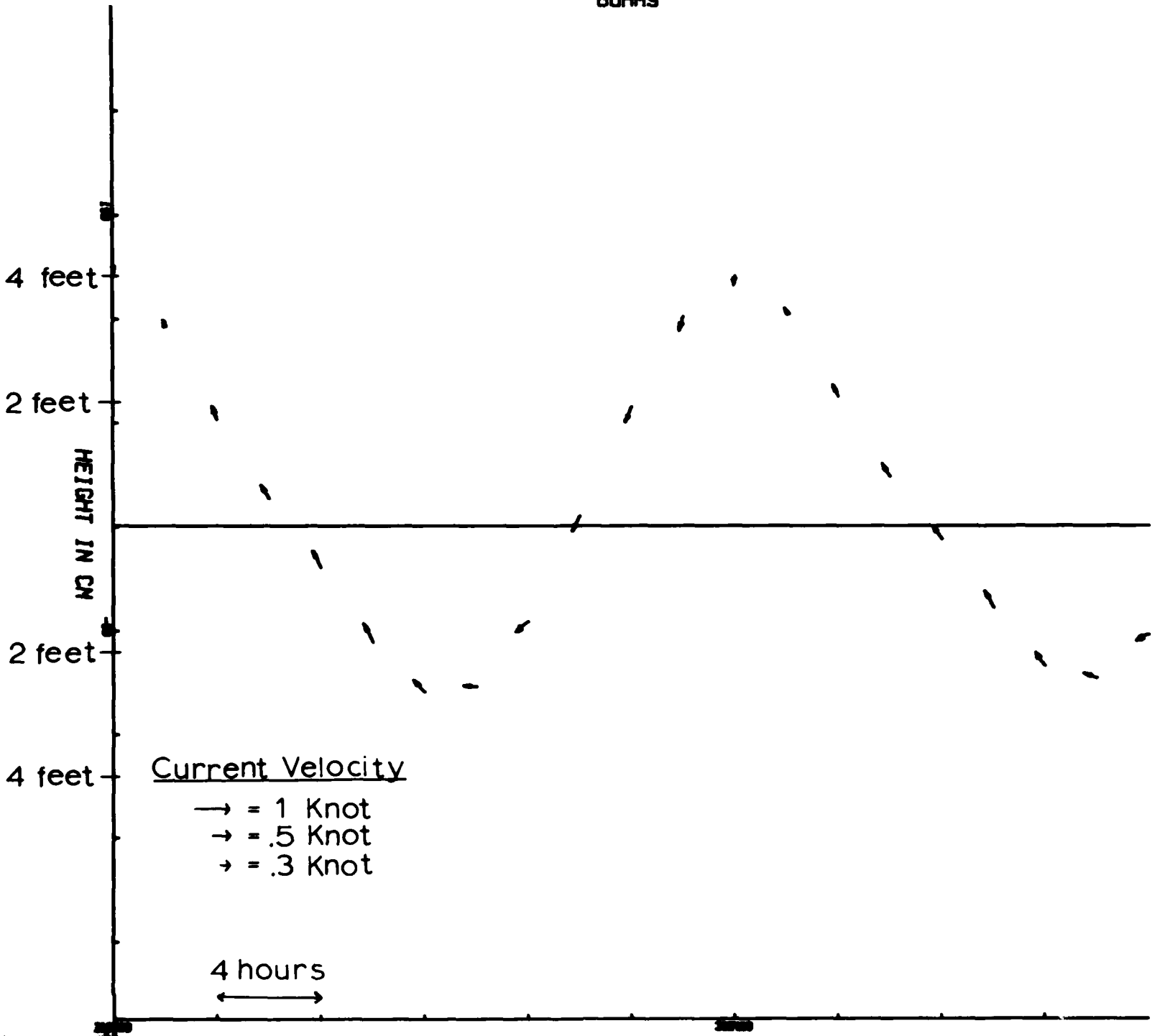

FIGURE 26
CEN10